Remarks

Claims 1-21 are pending in this Application. Claims 1-21 have been Rejected This Amendment Amends Independent Claims 1, 4 and 7 and Responds to the Examiner's Rejections. Claim 11 has also been Amended.

Claim Rejection 35 U.S.C. 102(a)

The Examiner states that

> 1. Claims 4, 7, and 9-11 are rejected under 35 U.S.C. 102(b) as being anticipated by Gunapala et al. (US 6,211,529 B1).

Specifically

The Examiner states that

> Regarding claim 4, Gunapala et al. teach a multi-wavelength detector system used in cameras, comprising a focal plane array (col. 5, lines 33-37); a voltage source (Figure 5, item 90; col. 8, lines 8-10) adapted to supply a bias voltage (col. 8 lines 9-10); first-wavelength detectors coupled to the voltage source, the first-wavelength detectors having non-parallel sides (Figure 5, item 11), the first-wavelength detectors being adapted to detect energy at a first range of wavelengths when the voltage source supplies the first bias voltage, the first-wavelength detectors further being adapted to generate photocurrents proportional to the detected energy at the first range of wavelengths (col. 12, lines 57-60) and second-wavelength detectors coupled to the voltage source, the second-wavelength detectors having non-parallel sides (Figure 5, item 11), the second-wavelength detectors being adapted to detect energy at a first range of wavelengths when the voltage source supplies the first bias voltage, the first-wavelength detectors further being adapted to generate photocurrents proportional to the detected energy at the second range of wavelengths (col. 12, lines 60-63); and CMOS circuitry (cot 5, lines 35; Figure 8, item 810) being configured to generate two-dimensional infrared images by detecting and processing the photocurrent (col. 10, lines 18-20).

Response

Applicant has Amended Claims 4, to specifically claim the limitation that the voltage source be tunable. The Applicant calls the Examiner's attention to page 6, paragraph [0027], line 1 wherein the tunable nature of the voltage source is indicated and further discussed in paragraph [0028] thru [0032]. As further explained, this feature, which was more fully described in Applicant's U.S. Patent 5,384,469 Choi for "Voltage-tunable multicolor infrared detectors," Issued on Jan 24, 1995 and incorporated by reference into this Application in paragraph [0001] taken in combination with the other features distinguishes over the prior art because no other Inventor has disclosed the role of the

tunable voltage source in producing a tunable quantum-well infrared photodetector (QWIP).

Regarding Claim 4, Gunapala, *et al.* described cameras that include focal plane arrays. However, the detection wavelength of the camera cannot be controlled by applied bias. Specifically, in column 12, lines 52-55, Gunapala, *et al.* states "Different quantum wells within a single QWIP can also have different absorptive properties. This effectively broadens the spectral response of the QWIP and makes a more robust detector." Gunapala, *et al.* went on to give an example in column 12, lines 60-63 that a QWIP can contain QWs that give 10.5 μm and 8.5 μm wavelength. It is clear that in Gunapala, *et al.* the purpose of including QWs with different absorptive properties is to broaden the spectral range and not to have controllable detection wavelengths. Cameras with broadened wavelength range cannot differentiate radiation from different wavelengths. It can be done only when each wavelength is detected one at a time. Without discussing the barrier thickness design, the electrons will not automatically accumulate in certain QWs for specific wavelength detection. Therefore, the structure described in Gunapala, *et al.* cannot be used for voltage tunable multi-color detection; hence it does not disclose a voltage tunable multi-wavelength detector system with a tunable voltage source. In fact, Gunapala, *et al.* teaches in column 12, lines 31-40 that the way to vary the quantum well parameters are by varying the semiconducting materials (lines 31-37) or to adjust the stoichiometric ratios and thicknesses of the materials.

Gunapala, *et al.* goes on to state other ways to "achieve a similar electrical function." See column 13, lines 1-11:

> In addition, other materials in the QWIP, such as the electrical contact, reflecting, and stop-etch layers, can be substituted for or doped differently to achieve a similar electrical function. For example, the random reflecting layer used to generate angled, internal reflections within the quantum well structure can be replaced by diffraction gratings or similar optical structures which diffract or reflect radiation. Diffraction gratings are desirable in some applications, as they exhibit wavelength-dependent diffraction. These structures can therefore be used to narrow the spectral response of the QWIP.

This again indicates that Gunapala, *et al.* did not contemplate, does not teach and hence did not disclose the use of a voltage tunable source to detect multiple wavelengths.

In addition, Applicant respectfully disagrees with the Examiner that Gunapala, *et al.* discloses "first-wavelength detectors coupled to the voltage source, the first-wavelength detectors having non-parallel sides (Figure 5, item 11)," and "second-wavelength detectors coupled to the voltage source, the second-wavelength detectors having non-parallel sides (Figure 5, item 11)," The Examiner is applying an interpretation of the Figure that is not consistent with the description in the Specification of the Referenced Patent. This description does not appear in the text of Gunapala, *et al.* and Figure 5 only

shows the setup for detector material characterization. For this purpose, a detector having a large area is made to allow individual wire bonding to the top contact 92b. With a large detector area, the exposed sidewall area is insignificant in comparison with the detector area. (Figure 5 is a sketch not in scale.) The amount of light reflected from these edges is extremely small and the light coupling is very inefficient. Therefore, Gunapala *et al.*, unlike Applicant's Invention, did not rely on these sidewalls to redirect light. Item 11 in Figure 5 of Gunapala, *et al.* refers to the multiple quantum wells described at column 7, line 67 rather than a slanted sidewall. Gunapala, *et al.* polished a 45 degree facet reference number 520 described at column 8, line 47 to allow the light (hv) entering into the detector area at an angle **without** redirection. See also Gunapala, *et al.* column 8, lines 43-51.

Gunapala *et al.* did not describe using angle sidewalls for light coupling anywhere in the document. For light coupling in the actual detector pixel of a focal plane array, Gunapala, *et al.* proposed using two coupling schemes. For the first scheme described at column 9, line 64 through column 10, line 3, Gunapala, *et al*, states: "Both the QWIP array 803 and CMOS multiplex substrate 810 have a 256 x 256 array of pixels. Each pixel 807 has a single QWIP similar to that described above. A gold, roughened, random reflecting surface such as discussed in respect to FIG. 7 is formed on top of the detectors to facilitate absorption of normal incident radiation."

For the second coupling scheme described in column 10 lines 37-41 Gunapala, *et al.* states: "The embodiment of FIG. 10 employs a special cross-grating in which the coupling efficiency is wavelength-dependent due to the periodicity of the cross-gratings. This cross-grating light coupling technique enables a narrow-bandwidth high-efficiency QWIP focal plane array."

Therefore, despite the appearance of the sketch at Figure 5, Gunapala *et al.* does not disclose using angle sidewalls to couple light into an imaging focal plane array camera.

Applicant's concept of integrating the light coupling mechanism described in U.S. Patent 5,485,015 Choi, Issued 16 January 1996, at column 9, line 20 through column 10, line 4 and in Figures 14 and 15 and incorporated by reference in paragraph [0001] of this Application marks an advance over the prior art not conceived by any other person of ordinary skill in the art none of whom other than Applicant would have been motivated to combine these two concepts. Applicant has spent years investigating the light coupling scheme which he disclosed in 5,485,015 Choi as is evidenced by the following publications recounting his record of investigation both before and after the Filing of the instant Application:

1. "Corrugated quantum well infrared photodetectors for normal incident light coupling", Applied Physics Letters, 69, 1446 (1996) C. J. Chen, K. K. Choi, M. Z. Tidrow and D. C. Tsui.

2. "Performance of corrugated quantum well infrared photodetectors", Appl. Phys. Lett., 71, 3045 (1997), C. J. Chen, K. K. Choi, W. H. Chang, and D. C. Tsui.

3. "Two-color corrugated quantum well infrared photodetector for remote temperature sensing", Appl. Phys. Lett., 72 7 (1998), C. J. Chen, K. K. Choi, W. H. Chang, and D. C. Tsui.

4. "Corrugated quantum well infrared photodetectors with polyimide planarization for detector array applications", IEEE Trans. of Elect. Devices, 45 1431 (1998), C. J. Chen, K. K. Choi, W. H. Chang, and D. C. Tsui.

5. "Corrugated infrared hot-electron transistors", Appl. Phys. Lett., 73 1272 (1998), C. J. Chen, K. K. Choi, W. H. Chang, and D. C. Tsui.

6. "Corrugated quantum well infrared photodetector for polarization detection", Appl. Phys. Lett., 74 862 (1999), C. J. Chen, K. K. Choi, L. Rohkinson, W. H. Chang, and D. C. Tsui.

7. "Corrugated quantum well infrared photodetector arrays", Photonic Tech Briefs, 23 15a (1999), K. K. Choi

8. "Enhanced corrugated QWIP performance using dielectric coverage", IEEE Trans. of Elect. Devices, 47, 653 (2000), N. C. Das and K. K. Choi.

9. "Electromagnetic modeling of quantum-well photodetectors containing diffractive elements", IEEE Journal of Quantum Electronics, 35 1870 (1999), L. Yan, M. Jiang, T. Tamir and K. K. Choi.

10. "New designs and applications of corrugated QWIPs", PHYSICA E, 7 112, (2000) K. K. Choi, C. J. Chen, K. L. Bacher and D. C. Tsui.

11. "Corrugated quantum well infrared photodetectors for material characterization" Journal of Appl. Phys., 88, 1612 (2000), K. K. Choi, C. J. Chen and D. C. Tsui.

12. "Broadband and narrow band light coupling for QWIPs" Inf. Phys. & Tech. 44, 309 (2003), K. K. Choi, C. H. Lin, K. M. Leung, T. Tamir, J. Mao, D. C. Tsui and M. Jhabvala.

13. "Light coupling characteristics of corrugated quantum well infrared photodetectors", IEEE J. of Quan. Electr., 40, 130 (2004), K. K. Choi, K. M. Leung, T. Tamir, and C. Monroy.

14. "Designs and Applications of Corrugated QWIPs", Inf. Phys. & Tech., 47, 76 (2005), K. K. Choi, C. Monroy, A. Goldberg, G. Dang, M. Jhabvala, A. La, T. Tamir, K. M.

Leung, A. Majumdar, Jinjin Li, D. C. Tsui.

If Applicant was not motivated before the submission of this Application to combine a tunable voltage source with angled sidewalls, it would appear that Gunapala, *et al.* neither anticipated nor would it make obvious Applicant's innovative combination.

Specifically

The Examiner states that

> Regarding claims 7, 9, and 11 Gunapala et al. (US 6,211,529 B1) teach a detector comprising a top electrical contact layer (Figure 5, item 510; col. 8, line 4) and bottom electrical contact layer (Figure 5, item 506; col. 8, line 2); a substantially transparent substrate being configured to admit light (GaAs substrate; col. 8, line 2; Figure 5, item 504); a voltage source (Figure 5, item 90; col. 8, lines 8-10) electrically coupled to the first contact and the second contact, the voltage source being adapted to supply a first bias voltage between the first contact and the second contact, the voltage source further being adapted to supply a second bias voltage between the first contact and the second contact; a top coupled to the first contact (Figure 5); a bottom coupled to the substantially-transparent substrate, the bottom adapted to receive the light admitted through the substantially-transparent substrate (Figure 5); sides extending from the top to the bottom, each side being substantially non-perpendicular to the bottom and non-perpendicular to an opposing side, each side being adapted to redirect the admitted light (Figure 5). Gunapala et al. further describe fabricating additional QWIP out of different materials (col. 12, lines 41-51) so that when the corresponding biased voltage is supplied the radiation wavelength is resonant and is absorbed by the quantum well (col. 7, lines 46-47), with each of these QWIP elements being a superlattice of quantum wells (Figure 3B).

Response
Applicant has Amended Claim 7, to specifically claim the limitation that the voltage source be tunable. Please see the discussion above as regards Claim 4 for how this tunable voltage source is not the same as the voltage source disclosed in Gunapala, *et al.* at column 8, lines 8-11 and hence, how Gunapala, *et al.* does not anticipate Claim 7 as Amended.

In addition, while the wording of Applicant's Claim 7 differs from that of Claim 4 in regard to the angled sides limitation reading in Claim 7, lines 13-14 as follows: "sides extending from the top to the bottom, each side being substantially non-perpendicular to the bottom, each side being adapted to redirect the admitted light;" the explanation above how Gunapala, *et al.* does not disclose through Figure 5 "sides extending from the top to the bottom, each side being substantially non-perpendicular to the bottom and non-

perpendicular to an opposing side, each side being adapted to redirect the admitted light." Gunapala, *et al.* clearly does not rely on nor disclose these sidewalls to redirect light.

Further note that since Claims 9 and 11 each Depend directly from Claim 7, the explanation above pertaining to the limitations of Claim 7 also apply to claims 9 and 11 and each of these Claims, as well as Claim 7 are Allowable over the alleged prior art. Inn addition, Claim 11 has been Amended to reflect the interposition of an energy relaxation layer between the first superlattice of quantum wells and the second superlattice of quantum well. Such an energy relaxation layer, described at paragraph [0042], lines 6-10, does not appear in the referenced material.

Specifically

The Examiner states that

> Regarding claim 10, Gunapala et al. (US 6,211,529 B1) disclose the limitations set forth in claim 7, and further disclose a first-wavelength QWIP element (Figure 3B) and a second-wavelength QWIP (Figure 3B, item 308), with different absorptive properties (col. 12, lines 52-67) wherein the first quantum well and the second quantum well are separated by a blocking barrier (Figure 3B, item 310).

Response

As Applicant has noted in regard to Claims 9 and 11, Claim 10 Depending directly from Claim 7 contains all of the limitations of claim 7 and hence is Allowable over Gunapala, *et al.*

Specifically

The Examiner states that

> Regarding claims 15 and 16, Gunapala et al. disclose voltage-tunable multicolor (Abstract) infrared (I R) detector comprising: a substantially-transparent substrate (GaAs substrate; col. 8, line 2; Figure 5, item 504); adapted to admit light; sides extending from the top to the bottom (Figure 5), each side being substantially non-perpendicular to the bottom and non-parallel to the opposing side, each side being adapted to redirect admitted light and a superlattice first-wavelength QWIP element (Figure 3B) and a superlattice second-wavelength QWIP (Figure 3B, item 308), with different absorptive properties (col. 12, lines 52-67).

Response

Applicant Respectfully disagrees with the Examiner concerning the content of the Abstract of Gunapala, *et al.*, which reads as follows:

Abstract

> An $Al_xGa_{1-x}As/GaAs/Al_xGa_{1-x}As$ quantum well exhibiting a bound-to-quasibound intersubband absorptive transition is described. The bound-to-quasibound

transition exists when the first excited state has the same energy as the "top" (i.e., the upper-most energy barrier) of the quantum well. The energy barrier for thermionic emission is thus equal to the energy required for intersubband absorption. Increasing the energy barrier in this way reduces dark current. The amount of photocurrent generated by the quantum well is maintained at a high level.

Applicant Respectfully advances that the Abstract in Gunapala, *et al.* does not specifically describe a "disclose voltage-tunable multicolor (Abstract) infrared (I R) detector." Nor, as described above in regard to Claims 4, 7, 9, 11, and 10 does Gunapala, *et al.* disclose In Figure 5 nor elsewhere in the Specification the limitation that "each side being substantially non-perpendicular to the bottom and non-parallel to the opposing side, each side being adapted to redirect admitted light." There is clearly no indication anywhere in the cited reference that the sides are adapted to redirect admitted light. The following limitation being contained in both claims 15 and 16 as a condition of Depending from Claim 13 is the following: "sides extending from the substantially-planar surface, each side being substantially non-perpendicular to the substantially-planar surface, each side being adapted to redirect the light admitted through the substantially-planar surface."

Specifically

The Examiner states that

> Claims 12-14, 17, 18, and 20 are rejected under 35 U.S.C. 102(b) as being anticipated by Johnson et al, (US 2002/0125472 Al).

Specifically

The Examiner states that

> Regarding claims 12-14, Johnson et al. teach a voltage-tunable (page 2; paragraph 16) multispectral (Abstract) infrared (IR) detector comprising: a substantially-transparent substrate (GaSb substrate; Figure 3, item 311; page 4; paragraph 37) adapted to admit light; sides extending from the top to the bottom (Figure 3), each side being substantially non-perpendicular to the bottom and non-parallel to the opposing side, each side being adapted to redirect admitted light.

Response

Applicant draws the Examiner's attention to figure 3 of Johnson, *et al.* If the Examiner observes the *n*-type layer 312, it will be noted that the sides of the unit cell mesa walls described at page 2, paragraph [0016], lines 22-26 do not extend to substrate 311. Furthermore the explanation at paragraph [0016]:

> For example, the angle of the mesa sides of each unit cell can be selected so that radiation does not pass through the gap between unit cells, but instead is reflected

> off the inside of a unit cell's mesa walls so that it is detected by the photodiodes of the unit cell.

Indicates that the intent is that the light not pass through the side walls but that it be **detected** by the photodiodes. This is different than adapting the side **to redirect** the light. Johnson *et al.* teach using two P-N junction photodiodes to achieve voltage-tunable two-color detection. As those skilled in the art can testify, PN junction photodiodes are very different from QWIPs. This is the reason why the invention of QWIPs warranted a Patent. To name a few differences, a PN photodiode relies on optical transitions between valence and conduction bands, while a QWIP utilizes optical transitions within the same conduction band. **A PN photodiode absorbs normal incident light directly, and therefore does not need angle sidewall to redirect light.** PN photodiodes are broadband detectors. Two-color detector actually means two different cutoff wavelengths. Meanwhile, QWIPs are narrow band detectors. Two-color detector means two different peak wavelengths. The two types of two-color detectors have very different characteristics and thus very different applications.

The mechanisms in achieving voltage tunable detection are also dramatically different in the two detectors. The QWIP is N-type in the entire structure, and there are no PN junctions. Johnson, *et al.* utilizes the large impedance asymmetry of a PN junction under forward and reverse bias to achieve voltage tunable detection. The detector consists of two back-to-back connected PN junctions. This innovation cannot be applied to QWIPs as they have no PN junctions. Instead, Applicant's Invention placed energy relaxation layers periodically in QWIPs to provide a photocurrent asymmetry (while there is no impedance asymmetry). Although Johnson, *et al.* and Applicant's Invention are trying to achieve similar detector functionality, the basic detection mechanism and the voltage tunable mechanism are totally different. Since a photodiode absorbs light in all directions, **it does not need angle sidewalls to redirect light for absorption**. In contrast, QWIPs can only absorb parallel propagating light and thus absolutely need redirection. The design of light redirection is critical for the sensitivity of QWIPs. Paragraph 16 of Johnson, *et al.* only teaches to create a slightly angled trench between adjacent pixels just to eliminate the dead space between the pixels where the incident light will not be absorbed. Its sole purpose is to increase the fill factor of the pixel slightly. It does not try to change the polarization of light as required by QWIPs, and thus its design principle of the detector geometry is completely different than that discussed in 5,485,015 Choi. For example, for a large QWIP pixel with a thin material layer, one needs to make a large number of corrugations to increase its reflecting surfaces. On the other hand, for a large photodiode pixel, the dead space between pixels is negligible. One does not need slanted sidewalls in this case. This, the angle of the mesa sides discussed at paragraph [0016] of Johnson, *et al.* does not anticipate "sides extending from the substantially-planar surface, each side being substantially non-perpendicular to the substantially-planar surface, each side **being adapted to redirect the light admitted through the substantially-planar surface**. Again, the angled mesa walls in Johnson, *et a*l. not even extending to the

substrate, are not adapted to redirect the light there being a completely different design principle for the two detectors.

Specifically

The Examiner states that

> Regarding claim 17, Johnson et al. teach a light detection method comprising the steps of receiving incident radiation (page 2, paragraph 16); reflecting the incident radiation at an angled surface (paragraph 16; Figure 3); and directing the reflected radiation through a voltage-tunable (page 2; paragraph 16) multispectral (Abstract) infrared (IR) detector.

Response

As described above in regard to Claims 12-14, Johnson, *et al.* does not teach **directing** the reflected radiation through a voltage-tunable multispectral infrared detector; rather it teaches reflecting the radiation off of the mesa angle walls so that it is detected by the photodiodes which are absorb light directly in all directions. In the case of Johnson, et al. all that is necessary is that the radiation not pass through the gap between unit walls whereas in the case of Applicant's Invention the radiation must be directed through a voltage-tunable multi-color infrared (IR) detector and required by Claim 17.

Specifically

The Examiner states that

> Regarding claims 18 and 20, Johnson et al. teach the limitations set forth in claim 17 and further teach (page 2; paragraphs 15 and 16) supplying a first bias voltage to the voltage-tunable multi-color IR detector element to detect energy at a first range of wavelengths (shorter wavelength; Figure 28, item 201; page 2, paragraph 14) and supplying a second bias voltage to the voltage-tunable multi-color IR detector element to detect energy at a second range of wavelengths (longer wavelength; Figure 2B, item 202; page 2, paragraph 14).

Response

Since Johnson, *et al.* does not Anticipate the limitations of Claim 17 to include redirecting the radiation as explained above, Claim 18 Depending from Claim 17 and possessing all the limitations of Claim 17 and Claim 20 Depending from Claim 18, which Depends from Claim 17 also possessing these limitations are not anticipated by Johnson, *et al.*

Claim Rejections - 35 U.S.C. § *103*

The Examiner states that

> Claims 1-3 are rejected under 35 U.S.C. 103(a) as being unpatentable over

Gunapala et al. (US 6,211,529 81) in view of Majumdar et al. *Electron transfer in voltage tunable two-color infrared photodetectors.*

Specifically

The Examiner states that

> Regarding claim 1, Gunapala et al. teach a teach a multi-wavelength detector system used in cameras, comprising a focal plane array (col. 5, lines 33-37); a voltage source (Figure 5, item 90; col. 8, lines 8-10) adapted to supply a bias voltage (col. 8 lines 9-10); a top electrical contact layer (Figure 5, item 510; col. 8, line 4) and bottom electrical contact layer (Figure 5, item 506; col. 8, line 2); a substantially transparent substrate being configured to admit light (GaAs substrate; col. 8, line 2; Figure 5, item 504); a matrix of detectors, each detector comprising: a top surface coupled to the top contact (Figure 5); sides extending from the top to the bottom, each side being substantially non-perpendicular to the bottom and non-perpendicular to an opposing side, each side being adapted to redirect the admitted light (Figure 5); first-wavelength detectors coupled to the voltage source, the first-wavelength detectors having nonparallel sides (Figure 5, item 11), the first-wavelength detectors being adapted to detect energy at a first range of wavelengths when the voltage source supplies the first bias voltage, the first-wavelength detectors further being adapted to generate photocurrents proportional to the detected energy at the first range of wavelengths (cot. 12, lines 57-60) and second-wavelength detectors coupled to the voltage source, the secondwavelength detectors having non-parallel sides (Figure 5, item 11), the secondwavelength detectors being adapted to detect energy at a first range of wavelengths when the voltage source supplies the first bias voltage, the first-wavelength detectors further being adapted to generate photocurrents proportional to the detected energy at the second range of wavelengths (col. 12, lines 60-63). Gunapala et al. do not specify the first and the second bias voltages being positive and negative respectively. Majumdar et al. *Electron transfer in voltage tunable two-color infrared photodetectors,* teach two-color quantum-well infrared photodetectors (Abstract). Majumdar et al. further specifies CQWIP (Figure id). Majumdar et al, further teach a positive bias for detecting lower wavelengths and a negative bias for detecting higher wavelengths (page 4628, Responsivity section, paragraph 2). At the time the invention was made, it would be obvious to one of ordinary skill in the art that the first and second bias voltages could be positive and negative voltages respectively as described by Majumdar et al. and perform the same function of selecting certain wavelength bands, as the voltages described by Gunapala et al.

Response

Applicant has Amended Claim 1 to specifically reflect that the voltage source in question is a tunable voltage source. As Applicant has explained above, in regard to claims 4 and 7, Gunapala, *et al.* does not disclose a tunable voltage source nor does it disclose "sides

extending from the top to the bottom, each side being substantially non-perpendicular to the bottom and non-perpendicular to an opposing side, each side being adapted to redirect the admitted light." Since, even assuming the motivation to combine the teachings of Gunapala, *et al.* with Majumdar, *et al.*, Applicant's Invention as Claimed would not be Obvious over the teachings of Gunapala, *et al.* in view of Majumdar, *et al.* since **at least** two limitations would be missing from the combined teaching.

Specifically

The Examiner states that

> Regarding claim 2, Gunapala et al. in view of Majumdar et al. *Electron transfer in voltage tunable two-color infrared photodetectors* teach the limitations set forth in claim 1 and further teach a first-wavelength QWIP element (Figure 38) and a second-wavelength QWIP (Figure 3B, item 308), with different absorptive properties (col. 12, lines 52-67) wherein the first quantum well and the second quantum well are separated by a blocking barrier (Figure 3B, item 310).

Response
Since Claim 2 Depends from Claim 1 and contains all of the limitations of Claim 1 and since as Applicant has explained above Claim 1 is not obvious over the teachings of Gunapala, *et al.* in view of Majumdar, *et al.* since **at least** two limitations would be missing from the combined teaching, Claim 2 is also is not obvious over the teachings of Gunapala, *et al.* in view of Majumdar, *et al.*

Specifically

The Examiner states that

> Regarding claim 3, Gunapala et at, in view of Majumdar et al. *Electron transfer in voltage tunable two-color infrared photodetectors* teach the limitations set forth in claim 1 and further teach each of these QWIP elements being a superlattice of quantum wells (Figure 3B).

Response
Since Claim 3 Depends from Claim 1 and contains all of the limitations of Claim 1 and since as Applicant has explained above Claim 1 is not obvious over the teachings of Gunapala, *et al.* in view of Majumdar, *et al.* since **at least** two limitations would be missing from the combined teaching, Claim 3 is also is not obvious over the teachings of Gunapala, *et al.* in view of Majumdar, *et al.*

Specifically

The Examiner states that

> Claims 5 and 6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gunapala et at. (US 6,211,529 81) in view of Mitra (US 20040108564 Al).

> Regarding claims 5 and 6, Gunapala et al. teach the limitations set forth in claim 4, however do not disclose expressly a display adapted to display the first-wavelength and second-wavelength image concurrently. Mitra teaches a multi-spectral super-pixel photodetector for detecting four or more different bands of infrared radiation (Abstract) and further teaches the use of an external system for displaying wavelengths from multiple bands (page 6, paragraph 57). It would be obvious to one of ordinary skill in the art to modify the invention of Gunapala et al. such that the first and second wavelength images are displayed concurrently as suggested by Mitra so that a quicker means for visualizing and manipulating the signals is provided.

Response
As Applicant has explained above, in regard to Claims 4 and 7, Gunapala, *et al.* does not disclose a tunable voltage source nor does it disclose "sides extending from the top to the bottom, each side being substantially non-perpendicular to the bottom and non-perpendicular to an opposing side, each side being adapted to redirect the admitted light." Since, even assuming the motivation to combine the teachings of Gunapala, *et al.* with Mitra, Applicant's Invention as Claimed would not be Obvious over the teachings of Gunapala, *et al.* in view of Mitra, *et al.* since **at least** two limitations would be missing from the combined teaching.

Specifically

The Examiner states that

> Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Gunapala et al. (US 6,211,529 B1)
>
> Regarding claim 8, Gunapala et al. teach the limitations set forth in claim 7, however do not disclose expressly metal contacts. It would be obvious to one of ordinarily skill in the art that in order to conduct electricity, the contacts must be made out of metal.

Response
As Applicant has explained above, in regard to Claims 4 and 7, Gunapala, *et al.* does not disclose a tunable voltage source nor does it disclose "sides extending from the top to the bottom, each side being substantially non-perpendicular to the bottom and non-perpendicular to an opposing side, each side being adapted to redirect the admitted light." Applicant's Invention as Claimed would not be Obvious over the teachings of Gunapala, *et al.* since **at least** two limitations would be missing from the teaching.

Specifically

The Examiner states that

Claims 19 and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Johnson et at. (US 2002/0125472 A1) in view of Mitra (US 20040108564 A1).

Regarding claims 19 and 21, Johnson et al. teach the limitation set forth in claims 18 and 20. Johnson et al. further teach that the array of photodetectors can be used in a camera, however do not specify generating the images from energy detected at the first and second range of wavelengths. Mitra teaches a multi-spectral super-pixel photodetector for detecting four or more different bands of infrared radiation (Abstract) and further teaches the use of an external system for displaying wavelengths from multiple bands (page 6, paragraph 57). It would be obvious to one of ordinary skill in the art to modify the invention of Gunapala et al. [sic] such that the first and second wavelength images are displayed concurrently as suggested by Mitra so that a quicker means for visualizing and manipulating the signals is provided.

Response

As described above in regard to Claims 12-14, and 17 Johnson, *et al.* does not teach **directing** the reflected radiation through a voltage-tunable multispectral infrared detector; rather it teaches reflecting the radiation off of the mesa angle walls so that it is detected by the photodiodes which are absorb light directly in all directions. In the case of Johnson, *et al.* all that is necessary is that the radiation not pass through the gap between unit walls whereas in the case of Applicant's Invention the radiation must be directed through a voltage-tunable multi-color infrared (IR) detector and required by Claim 17. Since Claim 19 Depends from Claim 18 , which in turn Depends from Claim 17, Claim 19 contains all of the limitations of Claim 17; since Claim 21 Depends from Claim 20, which in turn Depends from Claim 18, which in turn Depends from Claim 17 and even assuming the motivation to combine the teachings of Johnson, *et al.* with Mitra. (Note: Applicant assumes that the Examiner intended to combine the teachings of Johnson, *et al.* and Mitra rather than the teachings of Gunapala, *et a*l. as the Office Action states.) both Claims 19 and 21 would be Patentable over the teachings of Johnson, *et al.* in view of Mitra since it would not teach **directing** the reflected radiation through a voltage-tunable multispectral infrared detector. Note, if this was not an error, Applicant reiterates that even if there were motivation to combine Johnson, *et al.* with Mitra and Gunapala, *et al.*

Conclusion

Applicant believes that the Amendments made above respond to each and every one of the Examiner's Rejections and are such as to place the Application into Condition for Allowance. Applicant respectfully requests that a timely Notice of Allowance be issued in this case.

The Examiner is invited to telephone the undersigned at the local telephone number given below if, after considering this amendment, the Examiner is of the opinion that the Amendments made by Applicant have not resolved all outstanding issues in this case and brought the case into Condition for Allowance.

Respectfully submitted,

1 MAY 2006
DATE

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